W. H. Preece, Esq., F.R.S. (see "The Effects of Temperature on the Electromotive Force and Resistance of Batteries," "Proc. Roy. Soc.," vol. 36, p. 48), states "that changes of temperature do not practically affect electromotive forces, but that they materially affect the internal resistance of cells."

When the temperature of this element was lowered to about 145° F., the reactions before mentioned took place.

The tin taken up by the solution during heating commenced to precipitate, increasing as the temperature lowered, and the metal fell to the bottom of the cell in a form to be again utilised in the generation of the current.

The amount of local action or chemical corrosion which took place above 150° F. was excessive, but the metal taken up by the solution was very much less when the temperature of the electrolyte was not raised above the point of precipitation, 140° F.

The metal taken up below this point appears to be precipitated under the same conditions as that taken up at higher temperature, and seems to be precipitated whether the circuit be open or closed.

It will be seen on the curves F, G, H, I, J, with falling temperature that the electromotive force increased between 150° F. and 140° F., this might have been due to the reactions which took place during the precipitation of the metal.

Further investigations to determine the efficiency of this element would be of interest.

V. "Further Discussion of the Sun-spot Spectra Observations made at Kensington." By J. NORMAN LOCKYER, F.R.S. Communicated to the Royal Society by the Solar Physics Committee. Received May 5, 1886.

I have recently discussed, in a preliminary manner, the lines of several of the chemical elements most widened in the 700 spots observed at Kensington.

The period of observation commences November, 1879, and extends to August, 1885. It includes, therefore, the sun-spot curve from a minimum to a maximum and some distance beyond.

It is perhaps desirable that I should here state the way in which the observations have been made. The work, which has been chiefly done by Messrs. Lawrance and Greening, simply consists of a survey of the two regions F—*b* and *b*—D.

The most widened line in each region—not the widest line, but the *most widened*, is first noted; its wave-length being given in the observation books from Ångström's map. Next, the lines which

most nearly approach the first one in widening are recorded, and so on till the positions of six lines have been noted, the wave-lengths being given from Ångström's map, for each region.

It is to be observed that these observations are made without any reference whatever to the origin of the lines; that is to say, it is no part of the observer's work to see whether there are metallic coincidences or not; this point has only been enquired into in the present reductions, that is, seven months after the last observations now discussed were made. In this way perfect absence of all bias is secured.

It may further be remarked that the number of lines widened throughout a sun-spot period is about the same, so that the conditions of observation vary very little from month to month, and from year to year.

It may be further remarked that the absolute uniformity of the results obtained in the case of each of the chemical elements investigated indicates, I think, that the observations have been thoroughly well made; and, as a matter of fact, they are not difficult.

I first give tables (A, B, C) showing that for each of the chemical elements taken—iron, nickel, and titanium—the number of lines seen in the aggregate in each hundred observations is reduced from minimum to maximum, and that this result holds good for both regions of the spectrum.

I next give another table (D) showing that during the observations the lines recorded as most widened near the maximum have not been recorded amongst metallic lines by either Ångström or Thalén, and that many of them are not among the mapped Fraunhofer lines, though some of them may exist as faint lines in the solar spectrum when the observing conditions are best.

Table A.—Iron.

Iron Lines observed in Sun-spot Spectra at Kensington among the most Widened Lines.

	1st Hundred. 12th Nov., 1879, to 29th Sept., 1880.	2nd Hundred. 29th Sept., 1880, to 15th Oct., 1881.	3rd Hundred. 18th Oct., 1881, to 27th June, 1882.	4th Hundred. 1st July, 1882, to 28th August, 1883.	5th Hundred. 30th August, 1883, to 23rd June, 1884.	6th Hundred. 24th June, 1884, to 12th Feb., 1885.	7th Hundred. 18th Feb., 1885, to 24th August, 1885.
4863·2		—					
4870·2	—	—		—	—		
4871·3	—	—		—	—		
4875·5		—					
4877·4	—						
4884·2		—					
4886·5		—					
4888·0	—	—					
4890·0	—	—		—	—		
4890·6	—	—		—			
4907·0	—						—
4909·5				—			—
4918·0	—	—			—		
4919·8	—	—			—		
4956·7	—	—					
4981·8	—	—					
4982·5	—	—					
4983·5	—	—					
4984·8	—	—					
5004·9	—						
5005·2	—						
5006·5	—						
5011·5	—	—					
5014·2		—					
5019·2		—					
5026·2		—					
5027·2		—					
5038·2		—	—		—		
5040·1	—	—		—			
5041·2	—	—		—			
5047·8	—	—					
5049·4	—	—					
5051·0	—	—					
5064·4	—						
5068·1	—	—					
5071·9	—	—					
5074·0	—	—					
5075·8	—	—					
5077·9	—	—	—	—		—	
5078·8	—	—	—	—		—	
5082·2		—	—	—			
5090·2		—					
5096·3	—						
5098·2	—	—					
5107·0	—	—		—			
5109·8		—					
5121·0	—		—				
5123·2		—	—				
5126·5			—				
5133·0			—		—	—	—
5136·8	—	—	—				
5138·6	—	—					
5141·8	—	—					
5145·7	—	—	—	—			
5150·0		—	—	—			
5151·2		—	—				
5158·5		—		—			
5161·5		—		—			
5165·8	—		—				

TABLE B.—NICKEL.

List of most Widened Lines observed at Kensington.

	4865·3	4872·5	4903·9	4917·6	4935·1	4979·6	4983·5	5016·8	5034·6	5079·8	5080·6	5098·5	5099·2	5114·9	5136·8	5141·8	5145·7	5155·1	5168·3	5175·6
1st hundred lines							│		│						│	│	│			
2nd hundred lines							│	│	│	│	│	│			│	│	│			
3rd hundred lines										│	│				│		│	│		
4th hundred lines										│	│						│	│		
5th hundred lines																		│		
6th hundred lines											│									
7th hundred lines																		│		

TABLE C.—TITANIUM.

List of most Widened Lines observed at Kensington.

	4869·5	4884·2	4913·2	4964·5	4981·0	5006·6	5013·3	5035·2	5035·8	5037·8	5038·0	5038·7	5052·3	5061·3	5064·4	5071·8	5086·5	5119·9	5126·6	5144·5	5147·0	5151·2
1st hundred lines					│	│		│	│						│	│						
2nd hundred lines	│	│	│	│	│		│	│	│	│		│	│	│		│	│					│
3rd hundred lines								│	│	│		│		│	│			│	│		│	│
4th hundred lines									│		│			│						│	│	
5th hundred lines										│	│									│	│	
6th hundred lines																				│		
7th hundred lines	No lines.																					

TABLE D.—Unknown Widened Lines observed at Kensington.

	1st Hundred.	2nd Hundred.	3rd Hundred.	4th Hundred.	5th Hundred.	6th Hundred.	7th Hundred.
4865	..	..	..	..	..	1	..
4885	..	..	..	..	..	..	1
4888·3	1	..	..	..	..	..	..
4891·8	..	..	..	..	1	..	..
4910	..	..	..	2	..	..	..
4944	..	..	1	..	..	..	..
5017·2	..	1	..	..	..	..	..
5028·9	..	1	..	..	..	..	..
5030	..	1	..	..	..	..	..
5034·8	11	..	3	..	..	..	..
5037	..	..	..	..	..	1	..
5038·9	..	..	1	1	..	..	..
5042	..	..	3	..	..	..	..
5042·3	..	..	4	..	..	..	..
5043	..	1	..	..	..	..	..
5044·6	..	3	..	..	..	..	..
5061	..	..	2	..	..	..	3
5061·5	..	..	..	..	..	..	2
5062	..	..	..	..	..	..	5
5062·4	..	..	..	..	..	2	..
5062·8	..	..	..	3	..	2	..
5065	..	..	8	..	..	..	..
5067	..	1	..	..	..	..	..
5069·5	..	1	..	..	..	..	..
5070·8	..	1	..	..	..	..	..
5077	..	..	..	1	..	..	..
5079·5	..	..	..	..	..	2	..
5080	..	..	..	1	..	..	..
5081·5	..	..	..	..	..	..	3
5082	..	..	..	..	..	2	..
5083	..	..	..	..	..	2	..
5083·3	..	1	2	3	..	..	..
5084	..	1	..	..	..	..	3
5084·5	..	..	..	..	..	..	2
5086	..	..	17	..	1	..	..
5086·8	..	1	..	..	..	..	..
5087·7	..	1	..	..	..	..	..
5088·1	..	1	..	..	..	..	..
5088·6	..	1	..	..	..	..	..
5089·0	..	..	..	1	..	..	..
5101	..	..	..	..	..	..	1
5103·5	..	..	..	..	1	..	..
5112·1	..	6	22	4	2	1	..
5115·5	..	..	..	..	..	..	9
5116	3	6	24	3	..	..	..
5116·2	..	..	7	..	..	..	..
5118	4	..	14	..	..	..	..
5127	..	..	..	1	..	..	..
5127·5	..	..	1	..	..	..	..
5128·8	..	..	..	..	..	..	1
5129·6	..	17	19	4	..	..	..
5130	..	..	1	..	..	..	..
5132	..	14	21	6	..	..	..
5132·5	..	..	1	..	..	..	

	1st Hundred.	2nd Hundred.	3rd Hundred.	4th Hundred.	5th Hundred.	6th Hundred.	7th Hundred.
5132·8	..	..	..	3	..	..	..
5133·5	..	..	1	..	1	3	17
5133·8	..	30	47	43	62	3	27
5134	..	..	..	..	12	41	10
5134·4	..	..	..	..	..	19	..
5135	..	..	..	..	16	36	11
5135·5	..	33	15	..	53	36	20
5135·8	..	..	37	52	13	2	..
5136	..	..	4	..	9	22	27
5136·5	..	..	3	1	..	..	..
5137	..	..	2	2	1	..	..
5137·5	..	..	4	..	72	79	22
5137·8	..	12	35	64	13	10	3
5138	..	..	..	..	1	..	3
5139	..	..	..	..	1	..	1
5139·4	..	1	2	3	..	..	..
5140·4	..	2	..	..	..	..	..
5142·2	13	4	..	1	..	..	..
5142·8	..	21	7	19	2	..	..
5143	..	..	..	..	..	..	20
5143·2	..	..	2	..	..	..	..
5144·2	1	3	..	2	..	..	..
5144·5	..	..	..	..	1	..	..
5145·5	..	..	..	..	..	1	..
5146	..	..	36	12	..	..	..
5146·5	..	..	..	2	..	..	..
5148	..	..	..	..	..	..	1
5148·8	..	..	1	2	..	..	..
5149	2	32	31	36	4	..	35
5149·2	..	..	..	1	..	..	..
5149·5	..	..	..	4	..	..	29
5149·8	..	8	2	8	..	8	..
5150	..	..	..	1	..	..	..
5151·8	..	..	..	..	1	..	..
5153·8	..	..	..	..	1	..	..
5154	..	..	..	..	..	..	1
5155·4	..	..	..	..	1	..	..
5156	1	12	37	74	82	91	95
5156·5	..	..	..	..	8	..	..
5157·2	..	..	..	4	..	..	..
5159	..	..	1	8	13	11	41
5159·5	1	..	31	59	80	86	57
5160	..	..	1	4	..	9	..
5160·4	..	1	..	5	..	..	4
5162	..	..	9	7	61	67	62
5162·2	1	..	23	49	21	30	..
5175	..	..	..	..	..	..	3

The reduction of the latitudes of the spots is not yet completed.

The result of these observations may be thus briefly stated. As we pass from minimum to maximum, the lines of the chemical elements gradually disappear from among those most widened, their places being taken by lines of which at present we have no terrestrial representatives. Or, to put the result another way—at the mini-

mum period of sun-spots when we know the solar atmosphere is quietest and coolest, vapours containing the lines of some of our terrestrial elements are present in sun-spots. The vapours, however, which produce the phenomena of sun-spots at the sun-spot maximum are entirely unfamiliar to us.

The disappearance of the lines of iron, nickel, and titanium, and the appearance of unknown lines as the maximum is reached is shown by curves in fig. 1 given on the next page.

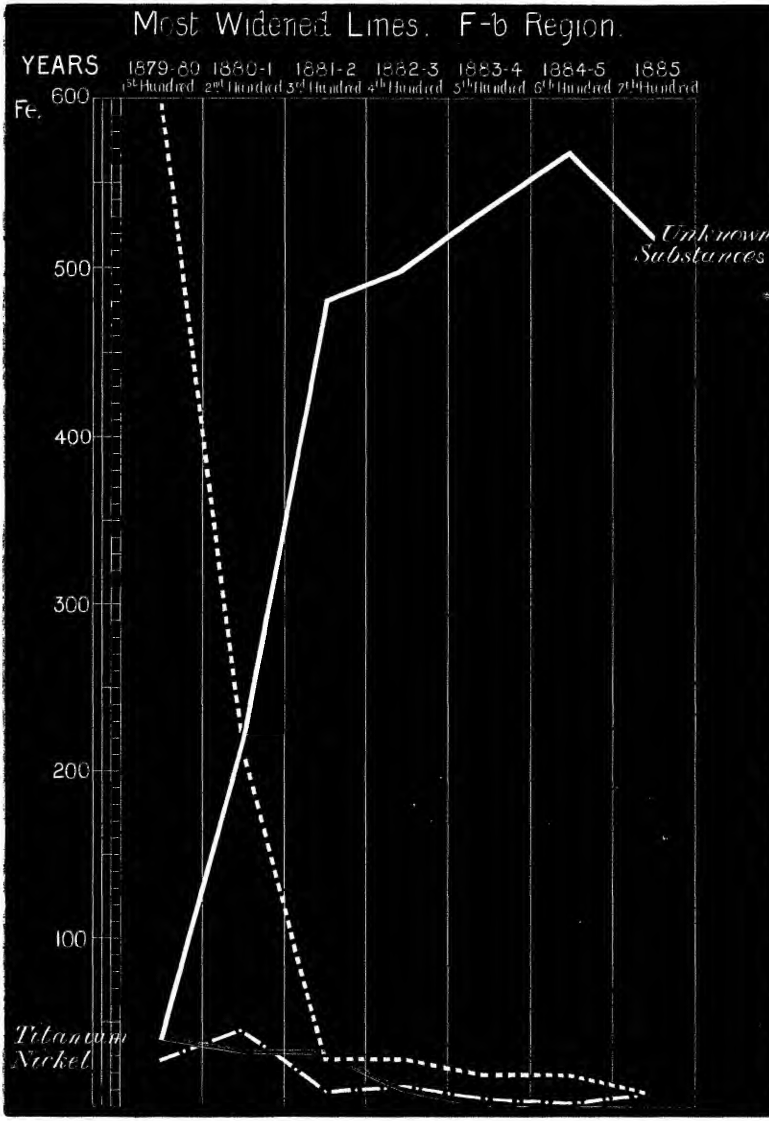
The results, in my opinion, amply justify the working hypothesis as to the construction of the solar atmosphere which I published some years ago. ("Proc. Roy. Soc.," vol. 34, p. 291.) In the region of the spectrum comprised between 4860 and 5160, I find in the case of iron, to take an instance, that sixty lines were distributed unequally among the spots in 1879 and 1880, many iron lines being visible in every spot. In the last observations, about the maximum, only three iron lines in all are seen among the most widened lines. These three lines also have been visible in four spots only out of the last hundred. The same thing happens with titanium and nickel, and with all the substances for which the reductions are finished.

I am quite content, therefore, to believe that iron, titanium, nickel, and the other substances very nearly as complex as we know them here, descend to the surface of the photosphere, in the downrush that forms a spot at the period of minimum, but that at the maximum, on the contrary, only their finest constituent atoms can reach it. It may also be remarked that these particles which survive the dissociating energies of the lower strata are not the same particles among the constituents of the chemical elements named which give the chromospheric lines recorded by Tacchini, Ricco, and myself.

Having thus found the working hypothesis to which I have referred stand the severe test which the sun-spot observations apply to it, I have gone further, and have endeavoured to extend it in two directions.

First. I found that the view to which the hypothesis directly leads, that the metallic prominences are produced by violent explosions due to sudden expansions among the cooler matters brought down to form the spots, when they reach the higher temperature at and below the photosphere level, includes all the facts I know touching spot and prominence formation. Thus, for instance, the close connexion between metallic prominences and spots; the entire absence of metallic prominences with rapid motion from any but the spot-zones; the fact that the faculæ always follow the formation of a spot and never precede it; that the faculous matter lags behind the spot as a rule; the existence of veiled spots and minor prominences in regions outside the spot-zones; the general injection of unknown substances into the

FIG. 1. Number of appearances of known and unknown lines.



lower levels of the chromosphere which I first observed in 1871, and which have been regularly recorded by the Italian observers since that time;—all these phenomena and many others which may be referred to at length on another occasion, are demanded by the hypothesis, and are simply and sufficiently explained by it.

With regard to the extensions of volume to which I have referred, I find that if we assume that metallic iron can exist in any part of the sun's atmosphere, and that it falls to the photosphere to produce a spot, the vapour produced by the fall of one million tons will give us the following volumes:—

Temperature.	Pressure.	Volume in cubic miles.
2,000° C.	380 mm.	0·8
10,000	760 „	1·8
20,000	5 atmos.	0·7
50,000	760 mm.	8·8
50,000	190 „	35·2

If we assume the molecule of iron to be dissociated ten times by successive halving, then the volume occupied will be 1024 times greater, and we shall have—

Temperature.	Pressure.	Volume in cubic miles.
50,000° C.	760 mm.	9,011
50,000	190 „	36,044

In these higher figures we certainly do seem nearer the scale on which we know solar phenomena to take place; the tremendous rending of the photosphere, upward velocities of 250 miles a second, and even higher horizontal velocities according to Peters, are much more in harmony with the figures in the second table than the first.

I may mention in connexion with this part of the subject, that the view of the great mobility of the photosphere which this hypothesis demands, so soon as we regard metallic prominences as direct effects of the fall of spot material, is further justified by the fact that if we assume the solar atmosphere, that is the part of the sun outside the photosphere, to be about half a million miles high, which I regard as a moderate estimate, the real average density of the sun is very nearly equal to one-tenth that of water, instead of being slightly greater than that of water, as stated in the text-books.*

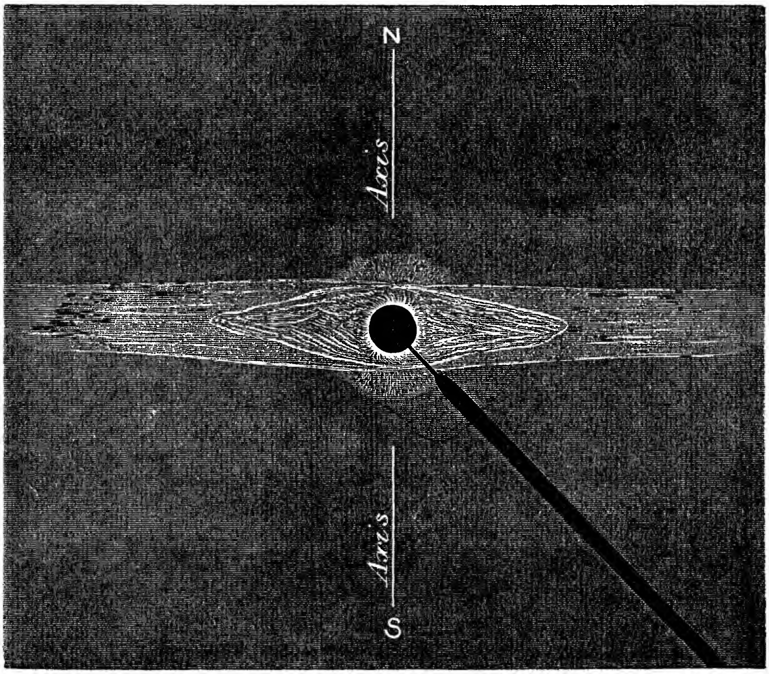
We can then only regard the photosphere as a cloudy stratum existing in a region of not very high pressure. It is spherical because it depends upon equal temperatures.

The second direction in which I have attempted to develop the hypothesis has relation to the circulation in the sun's atmosphere. I have taken the facts of the solar atmosphere as a whole, as they are recorded for us in the various photographs taken during eclipses since

* The density referred to water = 1·444 and to the earth 0·255, according to Newcomb.

Fig. 2. Minimum.

Tracing of Newcomb's observation of 1878, the brighter portion of corona being hidden by a screen. Shows the equatorial extension and concentric atmospheres.

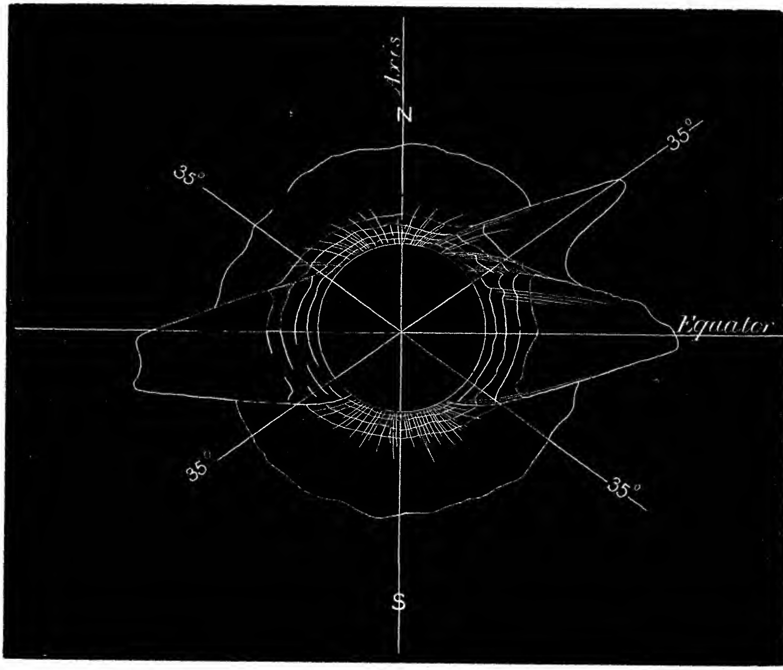


1871, and also in drawings made before that time, the drawings being read in the light afforded by these photographs.

I find that the working hypothesis at once suggests to us that the sun-spot period is a direct effect of the atmospheric circulation, and that the latitudes at which the spots commence to form at the minimum, which they occupy chiefly at the maximum, and at which they die out at the end of one period in one hemisphere, probably at the moment they commence to form a second one in the other (as happened in 1878—9), are a direct result of the local heating produced by the fall of matter from above descending to the photosphere, and perhaps piercing it. The results of this piercing are, the liberation of heat from below, and various explosive effects due to increase of volume, which, acting along the line of least resistance, give, as a return current, incandescent vapours ascending at a rate which may be taken as a maximum at 250 miles a second, a velocity sufficient to carry them to very considerable heights.

FIG. 3. MINIMUM.

Tracing of the results obtained by the cameras in 1878, showing inner portion of equatorial extension, and how the surfaces of it cut the concentric atmosphere in lat. 35 N. and S., or thereabouts.



The view of the solar circulation at which I have arrived may be briefly stated as follows :—

There are upper outflows from the poles towards the equatorial regions. In these outflows a particle constantly travels, so that its latitude decreases and its height increases, so that the true solar atmosphere resembles the flattened globe in Plateau's experiment (see photographs, 1878, and fig. 3).

These currents, as they exist in the higher regions of the atmosphere, carry and gather the condensing and condensed materials till at last they meet over the equator.

There is evidence to show that they probably extend as solar meteoric masses far beyond the limits of the true atmosphere, and form a ring, the section of which widens towards the sun, and the base of which lies well within the boundary of the atmosphere (fig. 2)

If we assume such a ring under absolutely stable conditions, there will be no disturbance, no fall of material, therefore there will be no

spots, and therefore again there will be no prominences. Such was the state of things on the southern surface of the ring from December, 1877, to April, 1879, during which period there was not a single spot observed the umbra of which was over 15-millionths of the sun's visible hemisphere.

Assume a disturbance. This may arise from collisions, and these collisions would be most likely to happen among the particles where the surface of the ring meets the current from the poles. These particles will fall towards the sun, thereby disturbing and arresting the motion of other particles nearer the photosphere, and finally they will descend with a crash on to the photosphere, from that point where the surface of the ring enters the atmosphere, some distance further down.

The American photographs in 1878 supply us with ample evidence that this will be somewhere about latitude 30°, and here alone will the first spots be formed for two reasons.

(1.) In the central plane of the ring over the equator, the particles will be more numerous, a rapid descent, therefore, in this central plane will be impossible, for the reason that the condensed matter has to fall perhaps a million of miles through strata of increasing temperature; there will, therefore, be no spots; and practically speaking, as is known, there are no spots at the equator, though there are many small spots without umbræ between latitudes 3° and 6° N. and S.

Above latitude 30°, as a rule, we have no spots, because there is no ring, and further the atmosphere is of lower elevation, so that there is not sufficient height of fall to give the velocities required to bring down the material in the solid form.

The lower corona where the corona is high, and it is highest over the equator, acts as a shield or buffer, volatilisation and dissociation take place at higher levels. Where this occurs, spots are replaced by a gentle rain of fine particles slowly descending, instead of the fall of mighty masses and large quantities of solid and liquid material.

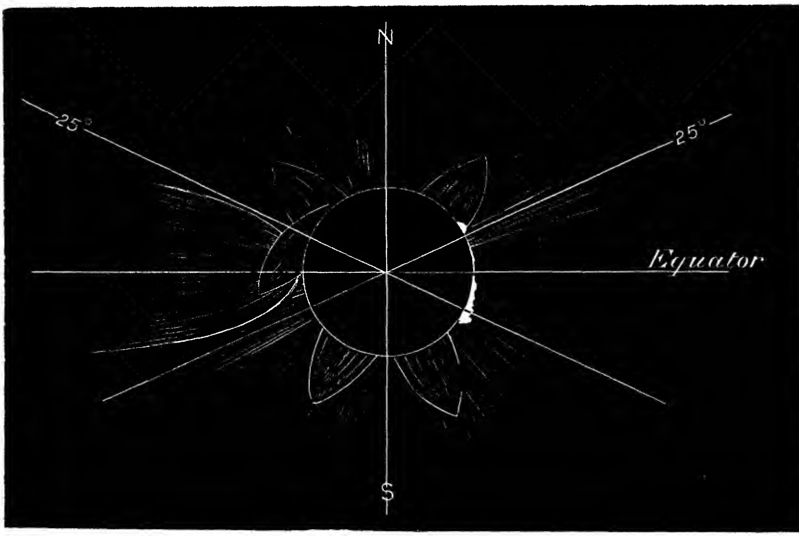
Volatilisation will take place gradually during the descent, and at the utmost only a veiled spot will be produced.

We know that when the solar forces are weak, such a descent is taking place all over the sun, because at that time the spectrum of the corona, instead of being chiefly that of hydrogen, is one of a most complex nature, so complex that before 1882 it was regarded by everybody as a pure continuous spectrum, such as is given by the limelight.

The moment the fall of spot material begins we get the return current in the shape of active metallic prominences, and the production of cones and horns which probably represent the highest states of

incandescence over large areas and extending to great heights; and, besides these, the production of streamers. See fig. 4.

FIG. 4. $1\frac{1}{2}$ years from maximum, 1858. Tracing of drawing by Liais, showing "cones."



Two results follow :—

1. In consequence of the increased temperature of the lower regions, the velocity of the lower currents towards the poles, and therefore of the upper currents from the poles, is enormously increased. The disturbance of the ring will therefore be increased.

2. Violent uprushes of the heated photospheric gases, mounting with an initial velocity of a million miles an hour, can also disturb the ring directly.

In this way the sudden rise to maximum in the sun-spot curve, and the lowering of the latitude of the spots, follow as a matter of course. And the part of the ring nearest the sun, its base, so to speak, is, it would appear, thrown out of all shape, and we get falls over broad belts of latitude N. and S.

Does this hypothesis explain then the slow descent to minimum and the still decreasing latitude? It does more, it demands it. For now the atmosphere over those regions where the spots have hitherto been formed is so highly heated, and its height is so increased, that any disturbed material descending through it will be volatilised before it can reach the photosphere.

The best chance that descending particles have now to form spots, is, if they fall from points in lower latitudes. The final period, there-

fore, of the sun-spot curve must be restricted to a very large extent to latitudes very near the equator, and this is the fact also, as is well known.

It will be seen that on this view, as the brightness and therefore the temperature of the atmosphere as we know increases very considerably from minimum to maximum, the masses which can survive this temperature must fall from gradually increasing heights.

It may be pointed out, how perfectly this hypothesis explains the chemical facts observed and associates them with those gathered in other fields of enquiry.

At the minimum the ring is nearest the sun, the subjacent atmosphere is low and relatively cool.

Particles falling from the ring therefore, although they fall in smaller quantity because the disturbance is small, have the best chance of reaching the photosphere in the same condition as they leave the ring, hence at this time the widening in many familiar lines of iron, nickel, titanium, &c.

The gradual disappearance of these lines from the period of minimum to that of maximum, is simply and sufficiently explained by the view that the spot-forming materials fall through gradually increasing depths of an atmosphere which at the same time is having its temperature as gradually increased by the result of the action I have before indicated, until finally when the maximum is reached, if we assume dissociation to take place at a higher level at the maximum, dissociation will take place before the vapours reach the photosphere, and the lines which we know in our laboratories will cease to be visible.

This is exactly what takes place, and this result can be connected as I have stated elsewhere, with another of a different kind. This hypothetical increasing height of fall demanded by the chemistry of the spots is accompanied by a known acceleration of spot movement over the sun's disk, as we lower the latitude—which can only be explained so far as I can see by a gradually increasing height of fall as the equator is approached.

There are two other points. (1.) The sunspot curve teaches us that the slowing down of the solar activities at the maximum is very gradual. We should expect therefore the chemical conditions at the maximum to be maintained for some time afterwards. As a matter of fact they have been maintained till March of the present year, and only now is a change taking place which shows us chemically that we are leaving the maximum conditions behind. (2.) The disappearance of the lines of the metallic elements at maximum is so intimately connected with an enormous increase in the indications of the presence of hydrogen, that there is little doubt we are in the presence of cause and effect. The hydrogen, I am now prepared to believe, is a direct consequence of the dissociation of the metallic elements.

It will be convenient to refer here to the facts which have been recorded during those eclipses which have been observed at the sun-spot minimum and maximum.

At the minimum the corona is dim; observations made during the minimum of 1878 showed that it was only $\frac{1}{7}$ as bright as the corona at the preceding maximum. There are no bright lines in its spectrum, and both photographic and eye observations proved it to consist mainly of a ring round the equator, gradually tapering towards its outer edge, which some observations placed at a distance of twelve diameters of the sun from the sun's centre.

The same extension was observed in the previous minimum in 1867, and the polar phenomena were observed to be identical in both eclipses. At the poles there is an exquisite tracery curved in opposite directions, consisting of plumes or *panaches*, which bend gently and symmetrically from the axis, getting more and more inclined to it, so that those in latitudes 80° to 70° start nearly at right angles to the axis, and their upper portions droop gracefully, and curve over into lower latitudes.

Although indications of the existence of this ring have not been recorded during eclipses which have happened at the period of maximum, there was distinct evidence both in the eclipses in 1871 and 1875 of the existence of what I regard as the indications of outward upper polar currents observed at minimum.

The fact that the solar poles were closed at the maximum of 1882, while they were open in 1871, is one of the arguments which may be urged that at times the whole spot-zones are surmounted by streamers, with their bases lying in all longitudes along the zones.

It was probably the considerable extension of these streamers earthwards, in 1882, which hid the finer special details at the poles, while in 1871, the part of the sun turned towards the earth was not rich in streamers of sufficient extension.

Touching these streamers, it is an important fact to be borne in mind, that no spots ever form on the poleward side of them.

It is obvious, therefore, that spots are not produced by the condensation of materials on their upper surfaces, for in that case the spots would be produced indifferently on either side of them, and the width of the spot-zones would be inordinately increased.

Although in the foregoing I have laid stress upon the indications afforded by the observations of 1878 of the existence of a ring, it should be remarked that, so far, the eclipse appearances on which the idea rests have not been observed at maximum. This, however, is not a fatal objection, because precautions for shielding the eye were necessary even in 1878 when the corona was dim; and if it is composed merely of cooled material it would not readily be photographed.

It may be urged by some that the phenomena observed in 1878 may only after all have been equatorial streamers.

It is obvious, therefore, that this point deserves the closest attention during future eclipses, until it is settled one way or the other.

May 13, 1886.

Professor G. G. STOKES, D.C.L., President, in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

Dr. Walter Lawry Buller (elected 1879) was admitted into the Society.

The following Papers were read:—

I. "On the Structure of Mucous Salivary Glands." By J. N. LANGLEY, M.A., F.R.S., Fellow and Lecturer of Trinity College, Cambridge. Received April 14, 1886.

The cells of mucous salivary glands I have previously described as consisting of a framework or network, containing in its spaces hyaline substance and granules.* I have also mentioned that during secretion the granules disappear from the outer portions of the cells.† A similar disappearance of granules has been found by Biedermann‡ to occur in the cells of the mucous glands of the tongue of the frog.

The granules of the mucous salivary glands are rendered very distinct by irrigating a mounted specimen of a fresh gland with moderately dilute solutions of neutral or alkaline salts. I have generally used sodium chloride solution 5 per cent., and sodium carbonate solution 3 per cent. In these fluids the granules can scarcely be distinguished from small fat globules; those of the submaxillary gland of the dog have a diameter of 1 to 2 μ, those of the orbital gland of the dog are a little larger.

In the resting gland the granules are fairly closely packed throughout the cell, in a line stretching from basement membrane to lumen

* "Proc. Camb. Philos. Soc.," vol. v, p. 25, 1883, and "Internat. Jour. Anat. and Histol.," vol. i, p. 69, 1884.

† "Jour. of Physiol.," vol. ii, p. 276, 1879.

‡ "Wien. Sitzungsb.," Bd. 86, Abt. iii, p. 67, 1882.

FIG 1. Number of appearances of known and unknown lines.

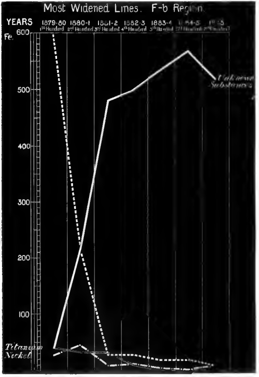


Fig. 2. Minimum.

Tracing of Newcomb's observation of 1878, the brighter portion of corona being hidden by a screen. Shows the equatorial extension and concentric atmospheres.

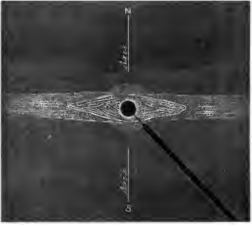


Fig. 3. Minimum.

Tracing of the results obtained by the cameras in 1878, showing inner portion of equatorial extension, and how the surfaces of it cut the concentric atmosphere in lat. 35 N. and S., or thereabouts.

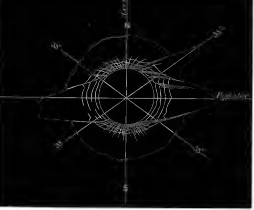


FIG. 4. $1\frac{1}{2}$ years from maximum, 1858. Tracing of drawing by Liais, showing "cones."